

Claims

1 1. A method for determining the quality of a formation fluid sample comprising:

2 (a) conveying a tool into a borehole on a work string, the borehole traversing a
3 subterranean formation containing formation fluid under pressure, the
4 borehole and work string having an annulus between the borehole wall and
5 work string, the annulus being filled with a pressurized fluid containing the
6 formation fluid;

7 (b) sealing a portion of the annulus by extending at least one selectively
8 extendable device disposed on the tool;

9 (c) exposing a port to the sealed portion of the annulus, the port being in fluid
10 communication with a test volume created by (a) and (b), the test volume
11 containing a fluid including the formation fluid;

12 (d) increasing the test volume at a first rate with a volume control device until the
13 test volume pressure falls below formation pressure; and

14 (e) sensing at least one characteristic of the fluid using a test device at least twice
15 while the test volume is being increased at the first rate.

1 2. The method of claim 1 wherein the at least one parameter of interest is selected from
2 a group consisting of (i) permeability, (ii) mobility, (iii) fluid compressibility,
3 (iv) contact points, and (v) pressure.

1 3. The method of claim 2 further comprising:

2 plotting the parameter of interest versus time to determine the quality of a sample.

1 4. The method of claim 2 further comprising:

2 matching a pumping rate to the parameter of interest to ensure single sample
3 acquisition.

1 5. The method of claim 2 further comprising:

2 detecting a pumping problem based on the parameter of interest.

1 6. The method of claim 2, further comprising:

2 determining a correlation coefficient for pressure; and

3 detecting a pumping problem based on the correlation coefficient.

1 7. The method of claim 3, further comprising:

2 monitoring a parameter of interest versus time to determining formation cleanup.

1 8. The method of claim 3 wherein sensing at least one characteristic of the fluid includes

2 a characteristic selected from the group consisting of (i) pressure, (ii) temperature,

3 (iii) volume, (iv) change in volume, (v) volume change rate, and (vi) compressibility.

1 9. The method of claim 3 further comprising:

2 monitoring a parameter of interest versus time to determine whether a formation
3 sample is in a single phase state.

10. An apparatus for determining at least one parameter of interest of a subterranean formation, the formation having a borehole drilled therein traversing a reservoir containing formation fluid under pressure, the apparatus comprising:

(a) a tool conveyable into the borehole on a work string, the borehole and work string having an annulus between the borehole wall and work string, the annulus being filled with a fluid;

(b) at least one selectively extendable device disposed on the tool to seal a portion of the annulus;

(c) a port exposable to the sealed portion of annulus;

(d) a test volume in fluid communication with the port, the test volume containing at least some formation fluid;

(e) a volume control device for varying the volume of the test volume to at plurality of predetermined rates including non-zero rates;

(f) a test device capable of sensing at least one characteristic of the fluid at least twice while the test volume is being increased each of the plurality of rates; and

(g) a processor capable of using the at least one sensed characteristic to modify each of the plurality of predetermined rates.

11. An apparatus according to claim 10 wherein the fluid volume control device includes at least one pump.

1 12. An apparatus according to claim **10** wherein the at least one parameter of interest is
2 selected from a group consisting of (i) pressure, (ii) permeability, (iii) mobility, (iv) fluid
3 compressibility, (v) temperature and (vi) contact points.

1 13. An apparatus according to claim **10** wherein the at least one sensor is selected from
2 the group consisting of (i) a pressure sensor; (ii) a volume sensor, and (iii) a temperature
3 sensor.

1 14. An apparatus according to claim **10** wherein the at least one sensor is at least two
2 sensors, the at least two sensors comprising a pressure sensor and a volume sensor.

1 15. An apparatus according to claim **10** wherein the at least one sensor is at least three
2 sensors, the at least three sensors comprising a pressure sensor, a volume sensor, and a
3 temperature sensor.

1 16. An apparatus according to claim **11** further comprising:

- 2 (i) a first controller disposed at a surface location for initial activation of the
3 volume control device;
- 4 (ii) a two way communication system for transmitting test initiation commands
5 downhole and for transmitting data up hole; and
- 6 (iii) a second controller disposed downhole for determining each of the plurality of
7 rates.

1 17. An apparatus according to claim **16** wherein the second controller further comprises a
2 processor and an algorithm installed in the processor for computing the formation pressure
3 based on the sensed fluid characteristics.

1 18. An apparatus according to claim **16** further comprising a processor for matching a
2 pumping rate to mobility.

1 19. An apparatus according to claim **16** further comprising a processor for detecting a
2 pumping problem based on the parameter of interest.

1 20. An apparatus according to claim **16**, further comprising: a processor for determining a
2 correlation coefficient and detecting a pumping problem based on the correlation coefficient.

1 21. A computer readable medium containing instruction that when executed by a
2 computer, perform a method for determining the quality of a formation fluid sample
3 comprising:

4 (a) conveying a tool into a borehole on a work string, the borehole traversing a
5 subterranean formation containing formation fluid under pressure, the
6 borehole and work string having an annulus between the borehole wall and
7 work string, the annulus being filled with a pressurized fluid containing the
8 formation fluid;

9 (b) sealing a portion of the annulus by extending at least one selectively
10 extendable device disposed on the tool;

- 11 (c) exposing a port to the sealed portion of the annulus, the port being in fluid
12 communication with a test volume created by (a) and (b), the test volume
13 containing a fluid including the formation fluid;
- 14 (d) increasing the test volume at a first rate with a volume control device until the
15 test volume pressure falls below formation pressure; and
- 16 (e) sensing at least one of (i) permeability, (ii) mobility, (iii) fluid compressibility,
17 (iv) contact points, and (v) pressure of the fluid using a test device at least
18 twice while the test volume is being increased at the first rate to determine the
19 quality of the formation fluid sample.